Attorney Docket No. MSU 4.1-596
Appl. No. 10/634,908
Decl. Dated: July 11, 2005
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appln. No. : 10/634,908 Confirmation No. 7369

Applicants : Brage Golding, Connie Bednarski-Meinke and Zhong-ning Dai

Filed : August 5, 2003

Title : HETEROEPITAXIAL DIAMOND AND DIAMOND NUCLEI PRECURSORS

TC/A.U. : 1722
Examiner : Felisa Carla Hiteshew

Docket No. : MSU 4.1-596

Customer No. : 21036

MAIL STOP AMENDMENT
COMMISSIONER FOR PATENTS
P. O. BOX 1450
ALEXANDRIA VA 22313-1450

DECLARATION UNDER 37 CFR 1.132

Sir:

Brage Golding states as follows:

(1) That he is an inventor in the above referenced application, and a Professor of Physics at Michigan State University, East Lansing, Michigan;

(2) That Kobashi et al U.S. Patent No. 5,863,324 shows how one grows single crystal diamond on Pt on a metallic oxide substrate. There is little of relevance to the present invention since Applicants' substrate is iridium with a (001) surface. The reference does not disclose *epitaxial growth*, i.e., a process wherein the film acquires a unique crystallographic orientation with respect to its substrate. Kobashi et al show that polycrystalline films of Pt, with some preferential (001) or (111) orientation, can be used to grow single crystal diamond. The process by which this happens may be similar to the way that highly-oriented films of diamond are grown on silicon: the process is called competitive growth, in which the fastest growing grains eventually dominate the film. Evidently, Kobashi et al learned how to induce preferential orientations of (001) or (111) diamond on Pt. They mention that X-ray evidence shows that the film is a single crystal, but proof is not presented in the patent. Nor did they reveal the overall size of the single crystal region.

The metallic oxide substrates claimed to work (including $SrTiO_3$ and sapphire) do not play a role in creating an epitaxial surface, although they may help in inducing a preferred orientation of the metal grains. This is why they can claim (Column 2, lines 63 to 67) that the process should work (or works) using glass, a completely disordered material, as a substrate.

(3) That Hörmann et al, Diamond and Related Materials 256-261 (2000)) describes epitaxial growth of diamond on metals. Hörmann et al showed that Ir can be grown on (001) $SrTiO_3$ and (001) diamond grown on the Ir. Hörmann et al also showed by X-rays that the misorientation of diamond grown on STO was about ten times smaller than diamond grown on Si (which is not regarded as epitaxial).

(4) The amended claims to the present invention are not obvious extensions of Hörmann et al. for a number of clear reasons. First, the inventors disclosed the process devised to induce the nucleation of diamond on Ir has increased the density of nuclei

from 10^9 per cm^2 to 10^{12} per cm^2 (page 24, lines 15 to 18 of the specification). This result has not been achieved by any other group to the present day. The major benefit is the enhanced smoothness of the films as a result of the rapid coalescence of the nanodiamond within 5-20 minutes of growth. Ths means that the inventors can produce good thin films in under 60 minutes.

(5) That the results of Hörmann et al are contrasted in the following Figures IA and IB (prior art) and IIA and IIB (present invention). Figures IA and IB show scanning electron micrograph results from Hörmann et al showing diamond grown at the center (a) and edge (b) of their substrate for 2 hours. Note the rough surfaces, poor coalescence, and the incomplete coverage in (b). Figures IIA and IIB show scanning electron micrographs of diamond from the present invention (taken from Fig. 8). This film was grown for only 1 hour. Note the smoothness at (a) center and (b) the edge. There is no evidence for incomplete coverage.

(6) That the present invention as claimed in the amended claims shows how to grow smooth diamond over a large area wafer. This is a quantitative improvement over the existing art. Also, it was shown that (001) diamond on (001) Ir can be grown by epitaxy using a (11-20) sapphire surface. Also it should be noted that (111) diamond can be grown only as single crystals over small microscopic regions using substrates such as (111) $SrTiO_3$ or (0001) sapphire. Growth on (11-20) sapphire in particular is completely non-obvious because of the differing symmetries of the Ir and (11-20) sapphire. The claimed diamond process is highly advantageous on sapphire because of the large size of available substrates, their crystallographic perfection, and the improved thermal strain mismatch.

(7) Thus the Kobashi et al patent has little bearing on the presently claimed invention since it does not relate to epitaxial growth. The present patent takes Hörmann et al as a starting point and demonstrates non-obvious processes for improving

quantitatively the physical properties of the resultant single crystal diamond films.

(8) That the undersigned declares further that all statements made herein of his own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of the Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Brage Golding
Date: 26 July 2005

Attachment: Figures IA and IB (prior art)
Figures IIA and IIB (present invention)

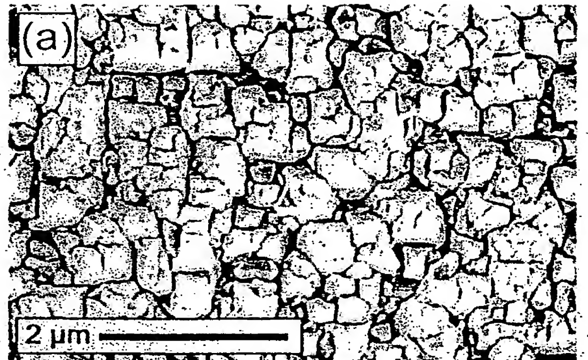

FIGURE IA
(prior art)

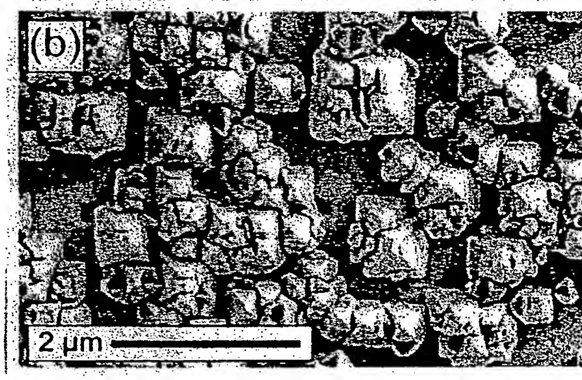

FIGURE IB
(prior art)

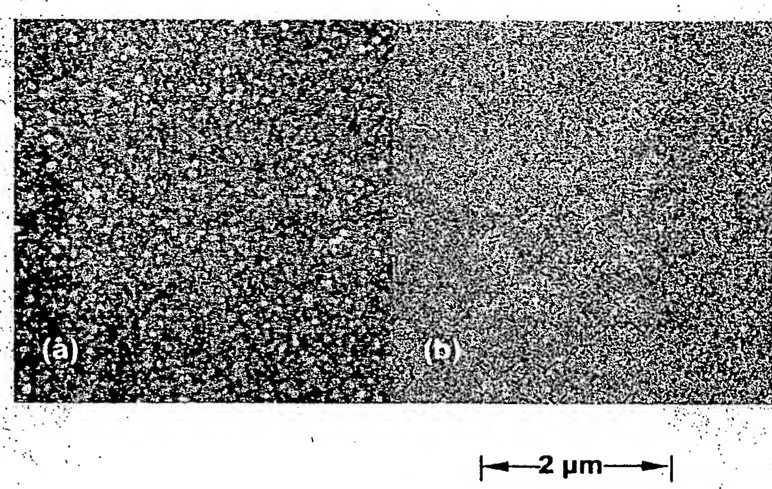

FIGURE IIA FIGURE IIB
(present invention)